Naval Research Laboratory

Stennis Space Center, MS 39529-5004

Lane Navigation Using Electronic Charts: A Training Manual for the NRL Moving-Map System

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January 31, 2003

20030312 216

REPORT DOCUMENTATION PAGE

1. REPORT DATE (DD-MM-YYYY)	2. REPORT TYPE	3. DATES COVERED (From - To)
January 31, 2003	Memorandum	

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Lane Navigation Using Electronic Charts: A Training Manual for the NRL Moving-Map System	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER 060378N

6. AUTHOR(S)	5d. PROJECT NUMBER 74-M035-03
Stephanie S. Edwards, Stephanie A. Myrick, and Marlin L. Gendron	5e. TASK NUMBER
	5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)	8. PERFORMING ORGANIZATION REPORT NUMBER
Naval Research Laboratory Marine Geosciences Division Stennis Space Center, MS 39529-5004	NRL/MR/7440--03-8287

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR / MONITOR'S ACRONYM(S)
Office of Naval Research 800 North Quincy Street Arlington, VA 22217	ONR
	11. SPONSOR / MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION / AVAILABILITY STATEMENT

Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES

14. ABSTRACT

The Naval Research Laboratory (NRL) Moving Map (MM) navigation system integrates relatively low cost, commercial off-the-shelf (COTS) DGPS/GPS hardware with government off-the-shelf (GOTS) moving-map software. The system consists of a DGPS/GPS antenna and receiver capable of establishing exact position(s) within 5-meter accuracy. DGPS/GPS data is processed by a high performance, ruggedized, water-resistant computer running segments of the FalconView program from the Portable Flight Planning System (PFPS) software suite. The system can be loaded with a full range of military standard format charts from the National Imagery and Mapping Agency (NIMA) and the National Oceanographic and Atmospheric Administration (NOAA), and various conversion chart imports (such as georectified GEOTIFF formats) of other non-military standard commercial products. Overlays depicting the battlefield geometry are used to enhance situational awareness.

15. SUBJECT TERMS

Moving-map navigation system

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE	UL	15	Stephanie Edwards
Unclassified	Unclassified	Unclassified			19b. TELEPHONE NUMBER (include area code) (228) 688-4423

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LANE NAVIGATION USING ELECTRONIC CHARTS: A TRAINING MANUAL FOR THE NRL MOVING-MAP SYSTEM

INTRODUCTION
The Office of Naval Research (ONR) has funded the Naval Research Laboratory (NRL), Stennis Space Center, MS to equip amphibious assault vehicles with Differential GPS Moving Map (MM) systems and electronic charting to test for improvements in lane navigation. This document is the training manual for the MM system software. The Training Manual is comprised of seven lessons, which provide instructions for system use.

OVERVIEW
The NRL MM navigation system integrates relatively low cost, commercial off-the-shelf (COTS) DGPS/GPS hardware with government off-the-shelf (GOTS) moving-map software (figure 1). The system consists of a DGPS/GPS antenna and receiver capable of establishing exact position(s) within 5-meter accuracy. DGPS/GPS data is processed by a high performance, ruggedized, water-resistant computer running segments of the FalconView program from the Portable Flight Planning System (PFPS) software suite. Table 1 lists system hardware and software components. The system can be loaded with a full range of military standard format charts from the National Imagery and Mapping Agency (NIMA) and the National Oceanographic and Atmospheric Administration (NOAA), and various conversion chart imports (such as geo-rectified GEOTIFF formats) of other non-military standard commercial products. Overlays depicting the battlefield geometry are used to enhance situational awareness.
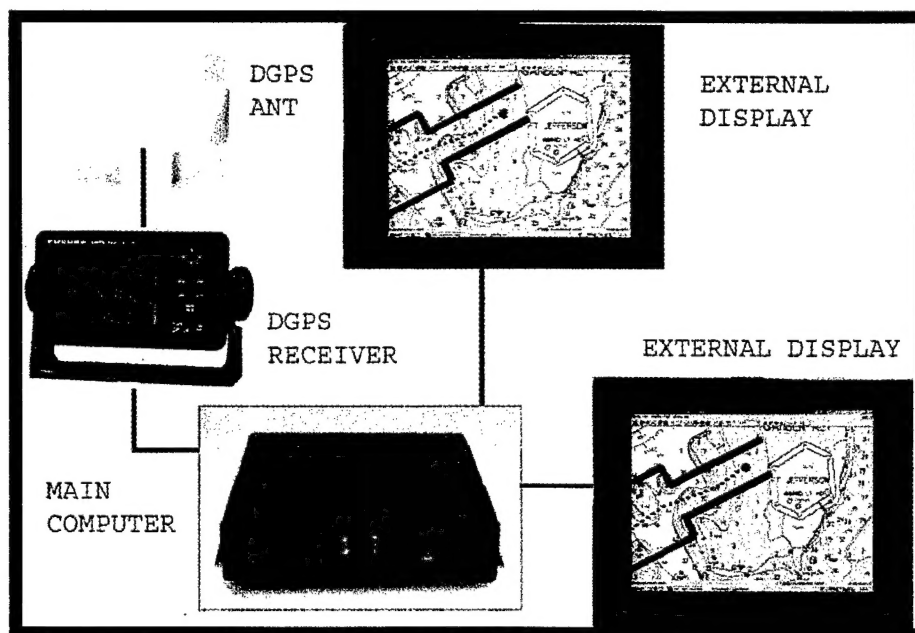

Figure 1. The NRL Moving Map System

Hardware Components	Software Components
Ruggedized, watertight, compact Intel 850MHZ Nauticomp computer requiring 28V DC	* Windows 2000 Operating System * FalconView (PFPS)
Furuno DGPS receiver	
Furuno DGPS antenna	
VGA-to-composite video converter	
1 or 2 Nauticomp display(s) 10.4"	
Amplified VGA splitter	

Table 1. MM system hardware and software components

LESSON 1. System Initialization

This section provides the necessary steps for initializing the MM System and making it available for use:
1. Turn on the system by flipping the power switch that is located at the forward right side of the case. The CPU will power up and automatically begin loading Windows 2000.
2. The display(s) are turned on using the individual display's power button that is located on the display front at the bottom right.
3. After Windows 2000 has completely loaded, double click on the desktop PFPS icon to invoke PFPS.

LESSON 2. Loading a Map

This section provides the necessary steps for loading a base map:
If FalconView has been previously been run on this system, the last map used will automatically be displayed. Otherwise, a default world map is displayed (figure 2) and a new map will need to be loaded.
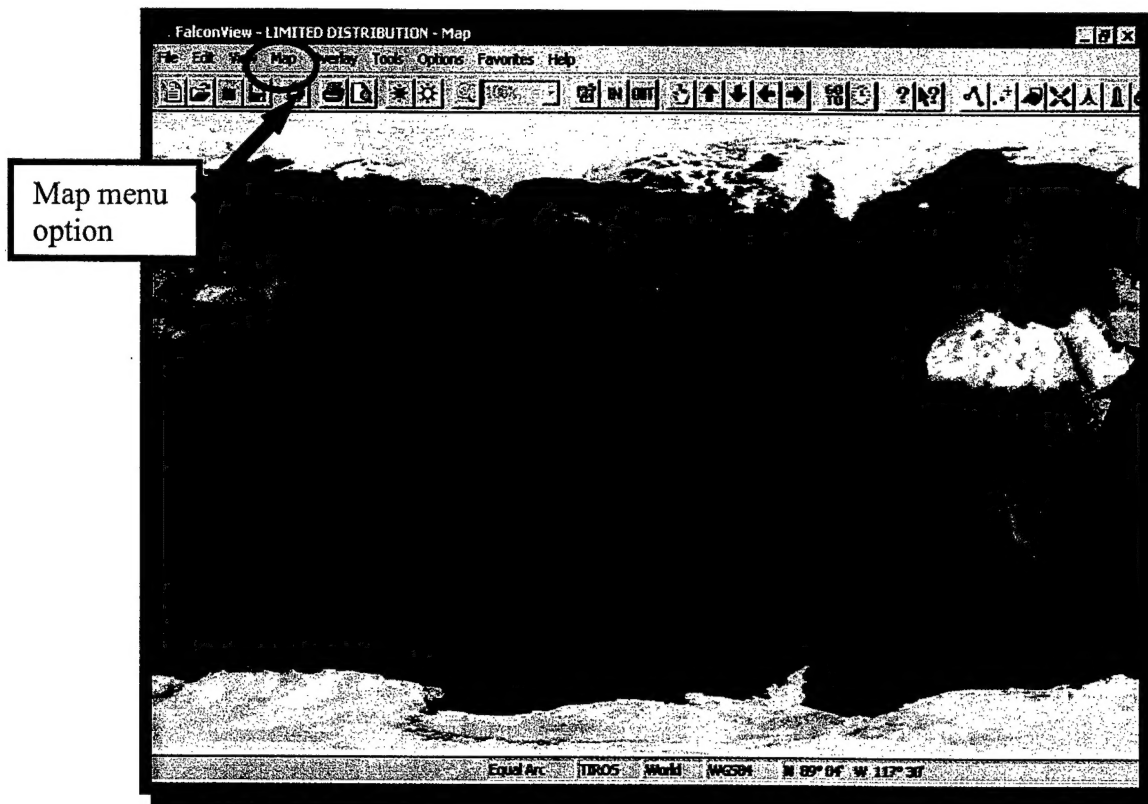

Figure 2. FalconView display showing the default world map

1. Click on the main menu Map option and select the "Map Data Manager" option.
2. Select the appropriate map data type from the drop-down menu (figure 3).
* Note regarding the loading of DNC charts: If loading a DNC chart, select "Digital Nautical Chart" from the Map menu before continuing.
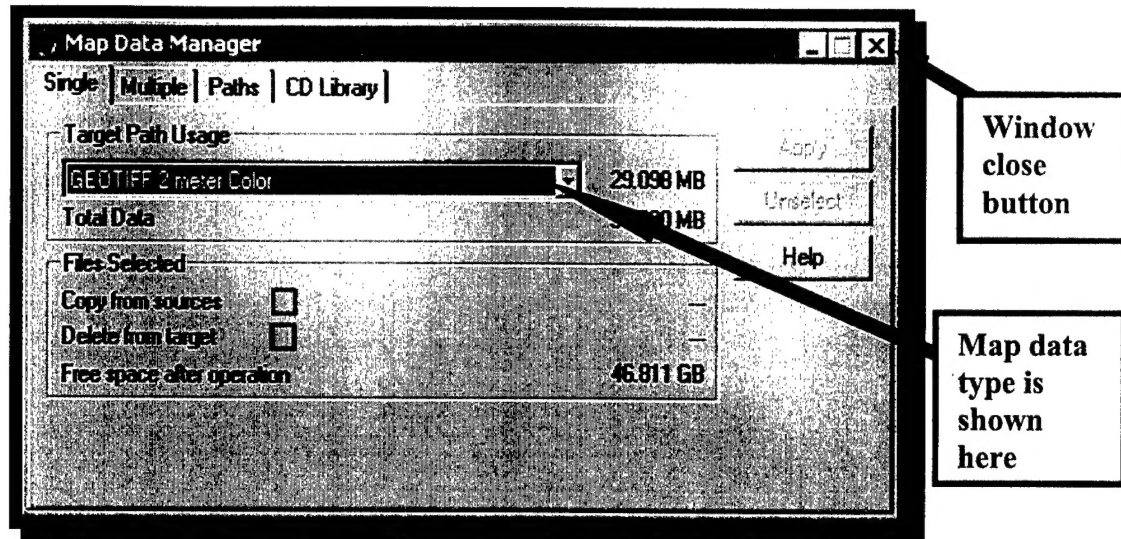
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Figure 3. Map Data Manager window. Select the appropriate map data type from the drop-down menu

3. Once selected, the geographic area to be displayed will be highlighted in green (figure 4). Zoom in until no longer possible, and then select the highlighted area by using the left mouse button to click on it one time (figure 5).
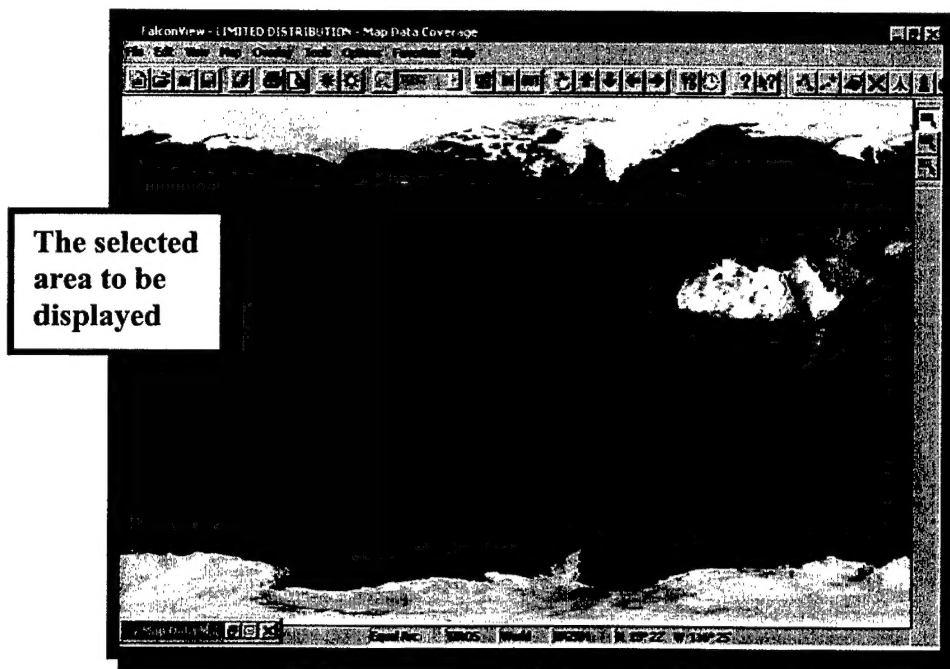

Figure 4. The selected geographic area to be displayed is highlighted in green
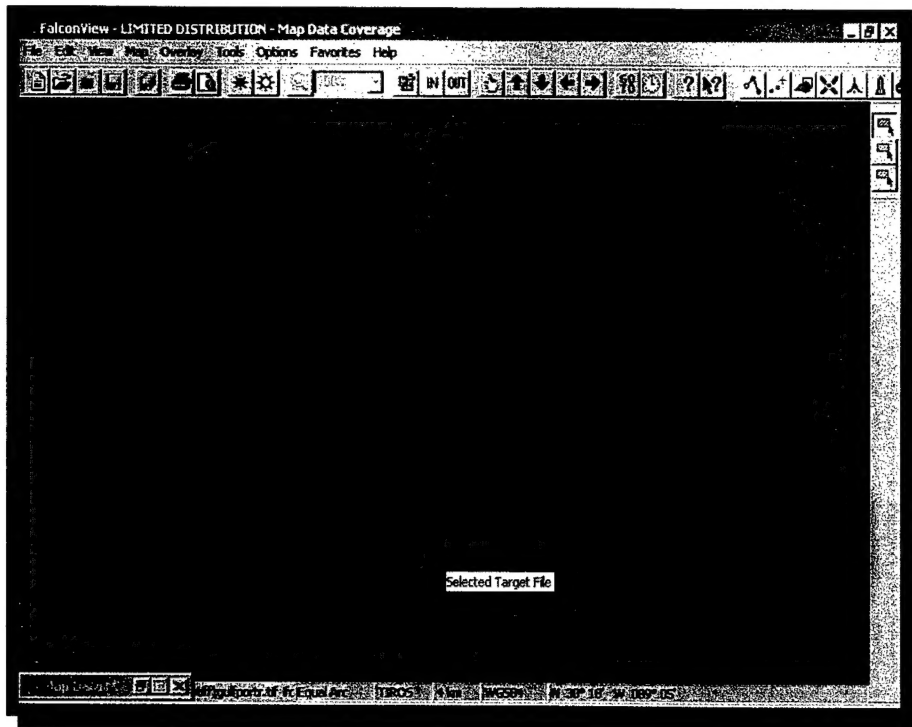
Figure 5. The zoomed-in display area. Select a specific area by clicking on it with the mouse.

4. After the highlighted area has been selected, click the right mouse button and select "Scale In." The actual chart will load and be displayed (figure 6).
5. The Map Data Manager can be closed at this time by clicking on the window close button (figure 3).
6. Use the scale drop down box (figure 7) to adjust the zoom level, and the arrows or hand tool to manipulate the chart.
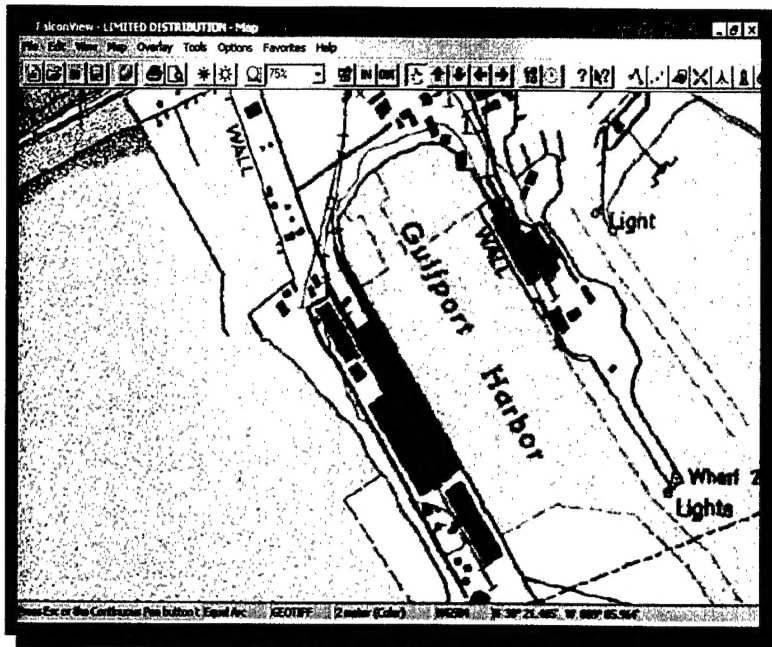
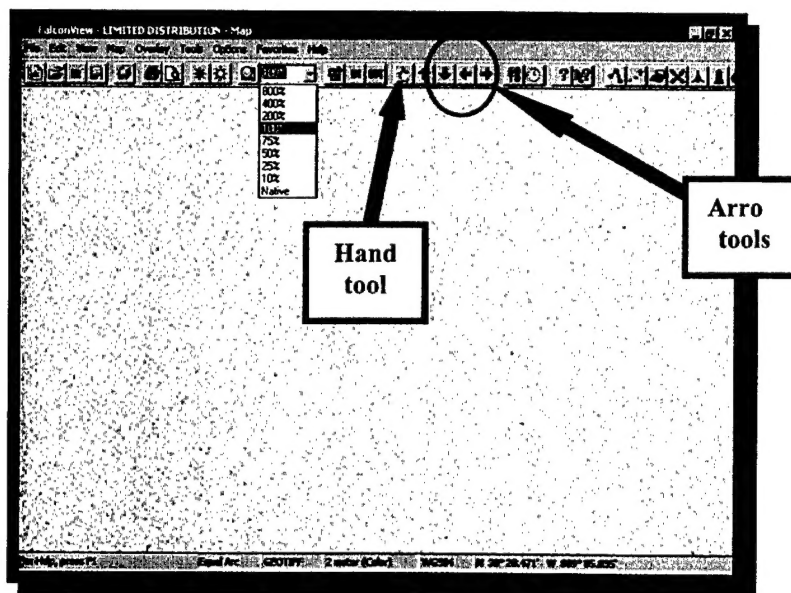Figure 6. Chart coverage of the selected area

Figure 7. The scale drop-down menu. Use this menu to zoom in or out. Use the arrow buttons or hand tool to move the chart.

LESSON 3. Selecting an Existing Route

This section provides the necessary steps for selecting a navigation route:

1. From the File menu, select "Open". The Open window will appear that shows available file types.
2. From the Open Window, select the "Route" file type and click OK (figure 8). The Route file folder will appear.
3. From the Open window for Route files, select the appropriate route file and click OK (figure 9). The prepared lane/course will be displayed on the map (figure 10).
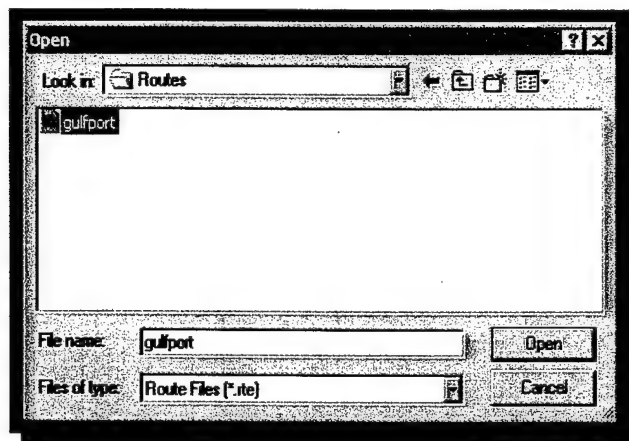

Figure 8. Open window showing available file types

Figure 9. The Open window for Route files. There is one Route file available in this figure.

Figure 10. Route file containing a prepared lane/course

LESSON 4. Creating a Route

This section provides all of the necessary steps for creating a new route:
1. Click on the Tools menu and select "Route Editor." An editor toolbar will be displayed on the right hand side of the screen (figure 11).

Figure 11. The Route Editor Toolbox

2. Click on the "Turn Point" button on the toolbar (the circle).
3. Click each point on the chart where a waypoint or turn is required. Repeat this step for each waypoint.
4. When finished entering the points, click on the "PFPS Point Editor" button on the tool bar (the pencil) to check/correct the coordinates.
5. To add lane width markings, select the "Route Properties" button on the toolbar (the route with colored corners).
6. Select the "Corridor" tab.
7. From this screen, the corridor (lane) can be toggled on and off, and the lane width can be set. Remember that the corridor width is from the centerline, rather than the entire width of the lane. To calculate the corridor width, divide the lane width by 2 and select the proper unit of measurement (i.e., feet, meters, yards). This screen also allows for the adjustment of line thickness and color.

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LESSON 5. Connecting to GPS

After loading the map and any overlays (routes, waypoints, etc), the system must be connected to the GPS receiver. This section provides all of the necessary steps for establishing a GPS connection:

1. Click on the Tools menu (figure 12) and select "GPS Tool." A GPS toolbar will be displayed on the right hand side of the screen.
2. Click on the topmost button on the GPS toolbox to connect to a GPS device (figure 13).
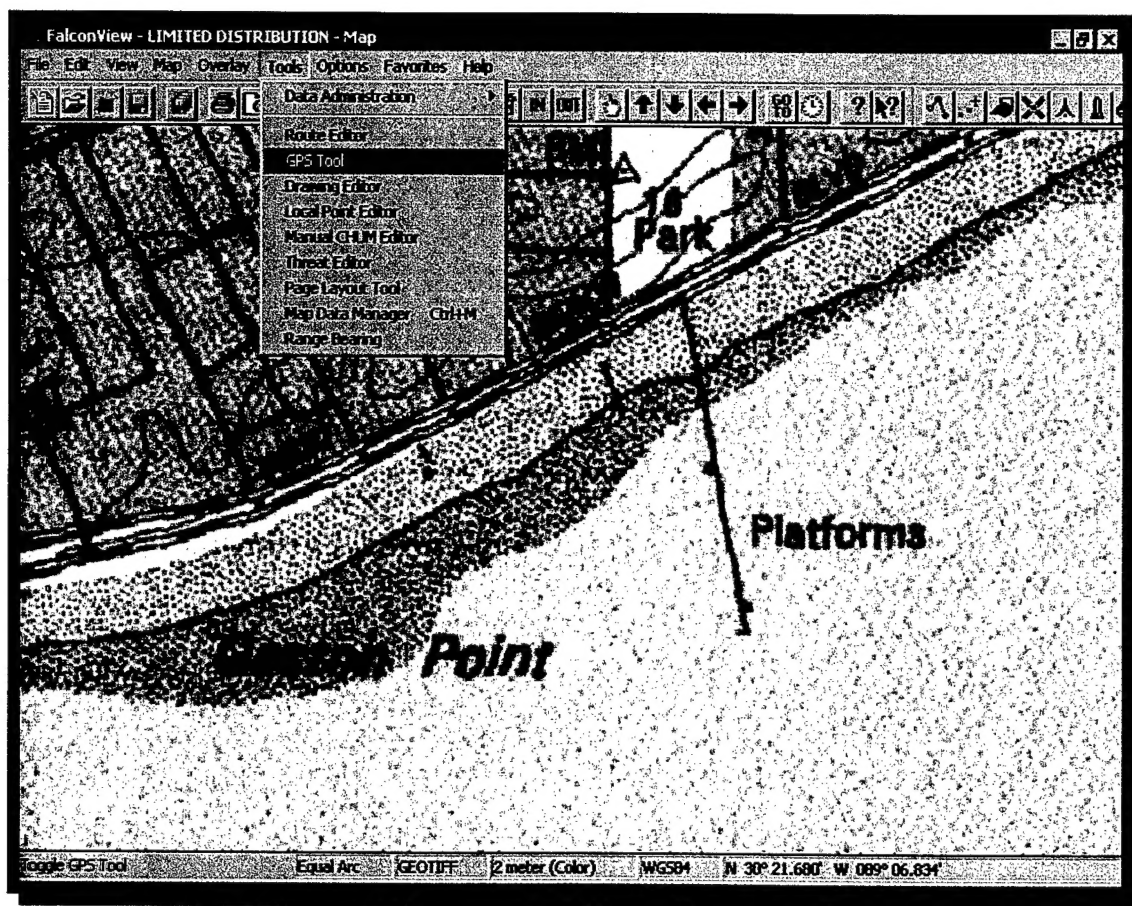

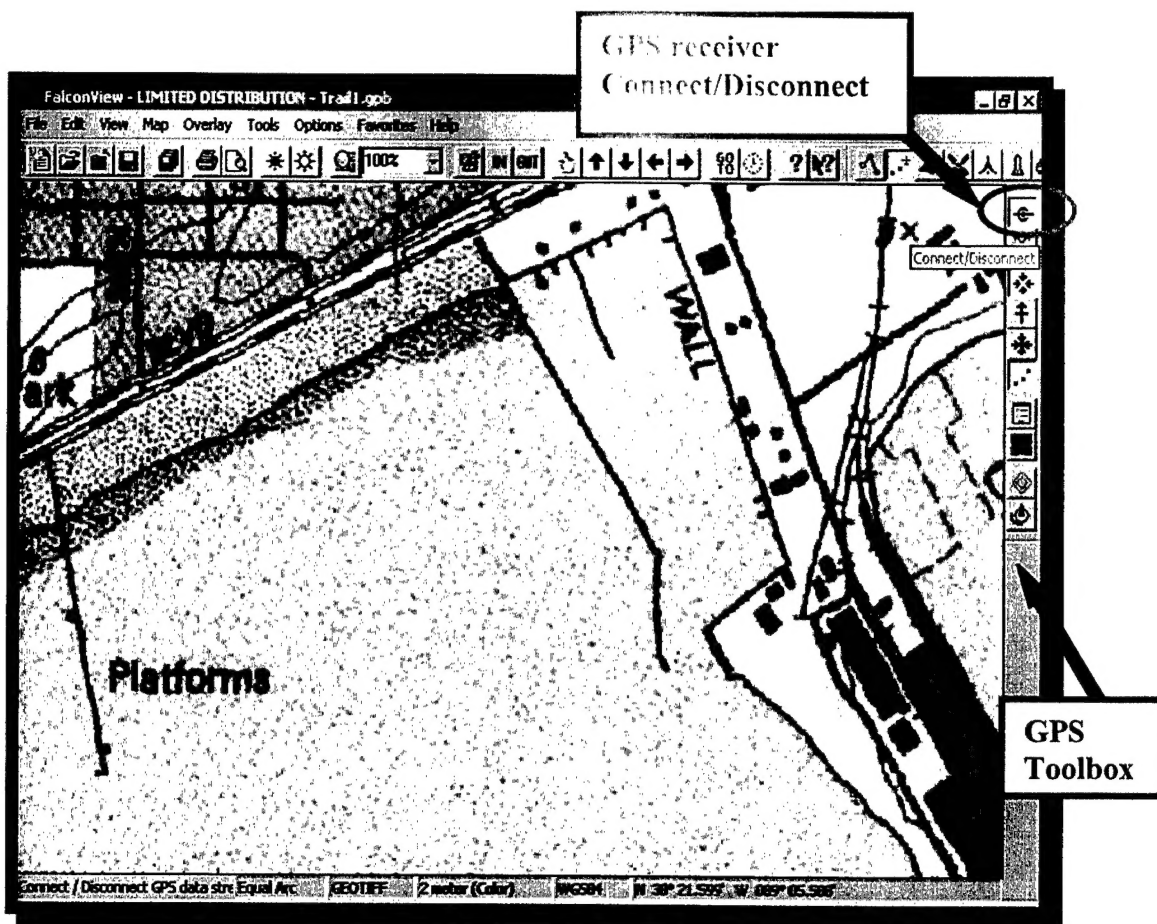Figure 12. The Tools menu with the GPS Tool option selected.

Figure 13. The GPS Toolbox with the Connect/Disconnect button selected

LESSON 6. Saving GPS Trails

This section provides all of the necessary steps for saving a trail that was run using GPS:
1. Select "Save As" from the file menu.
2. Enter a unique filename and click OK. To save more than one run, be sure to close the current GPS trail after saving and open a new one for each run. Otherwise, all runs will be saved to a single GPS file.

LESSON 7. Navigation using an Existing Route

This section describes navigation using an existing route:
To load an already existing route, refer to Lesson 5.
For example, figure 14 shows a course for the Gulfport, Mississippi test area. The course is drawn in green with the start and end location marked with a black-colored triangle. Turn points are labeled and marked with black-colored circles. Figure 15 shows a zoomed in view of the

surveyed test course with an overlay indicating the 50-yard lane width. Drivers must steer their vehicles along the centerline within and remain within this lane.
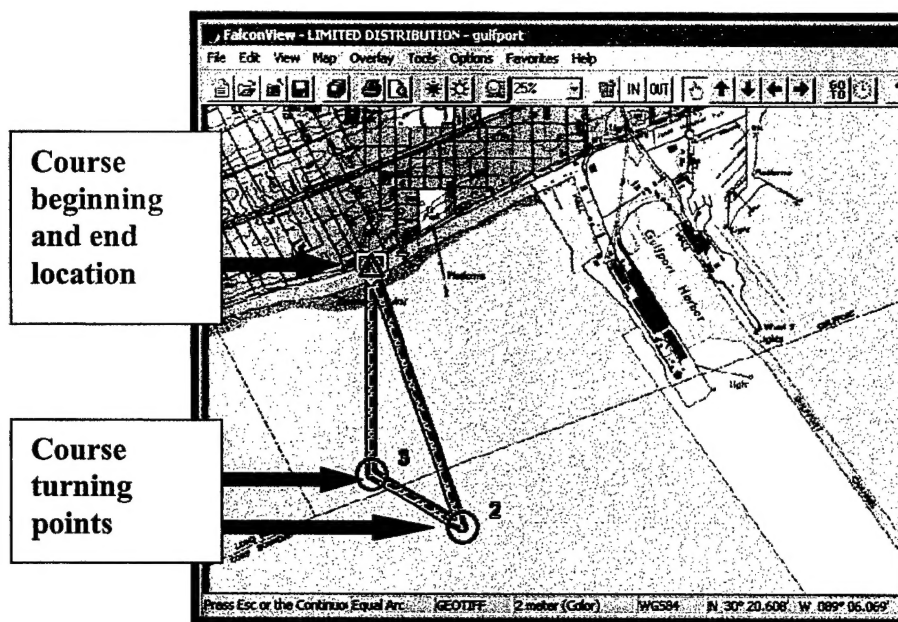

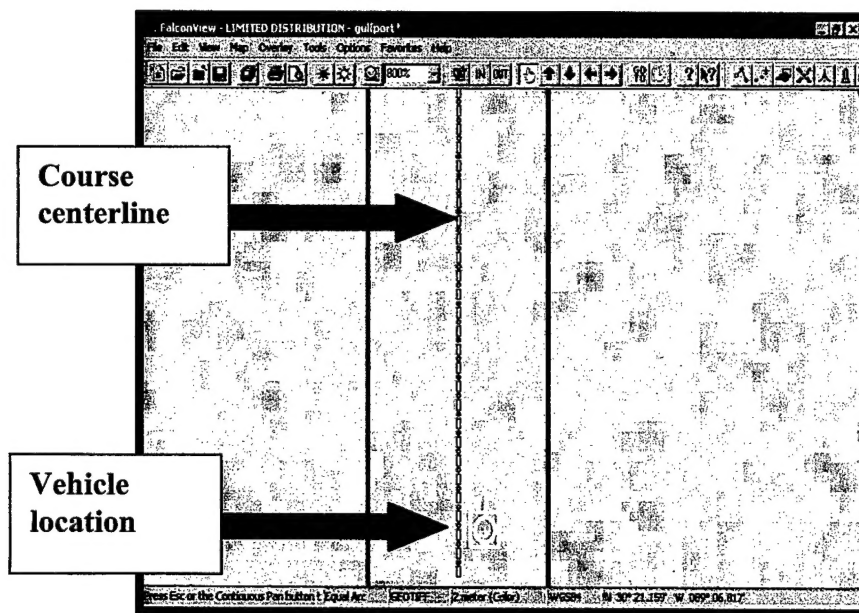Figure 14. A map of the Gulfport, MS test area

Figure 15. Trail zoomed in showing the 50-yard lane width test course overlay. The centerline is marked with a dashed line; a yellow symbol indicates the vehicle position as it travels within the navigation lane.

PFPS will be run in the *track up* moving-map display mode where the vehicle position is always indicated at the bottom on the screen (with a yellow symbol) and pointed forward (up) in the direction of travel (figure 15). The map movement scrolls from top to bottom. Therefore, when the vehicle is heading north, the top of the display is depicted as North, and when the vehicle is heading south, the top of the display is depicted as South. This mode resembles driving an automobile - if the vehicle began drifting to the right, the driver would steer left to remain in the lane. Figure 16 shows the driver and map display during the actual test in Gulfport.
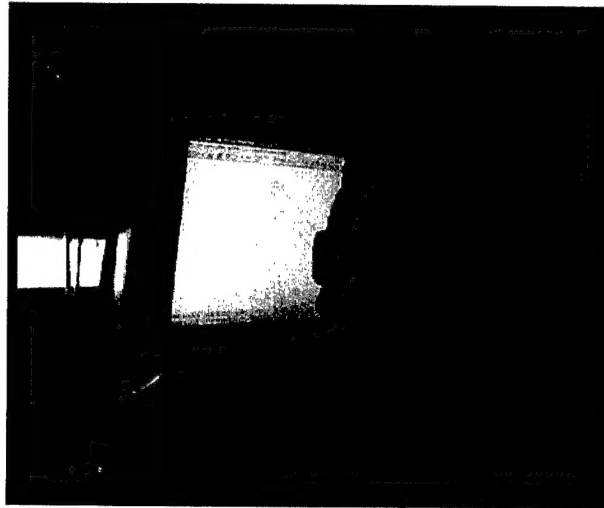

Figure 16. An AAV driver using the MM system during testing in Gulfport, MS.

➤ Note regarding turning points and steerage: When turning the vehicle, there may be a lag time between the vehicle's actual position and the position noted on the MM screen. This is due to the 1 second GPS update rate. In the Gulfport tests, this lag occasionally caused the driver to overcompensate when trying to stay in the lane, and result in the vehicle oscillating back and forth. To correct this, the driver would slow the vehicle, regain control, and then get back on course. It should be noted that this condition occurred infrequently, and was observed during the first test runs with inexperienced drivers. When this did occur, the vehicle remained within the lane. After the driver got used to the lag time, this was no longer a problem. A driver stated that experience, or "getting to know the system", completely solved the problem.

ACKNOWLEDGEMENTS